

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme

Programme Specific Outcome (PSO)

Students will be able to

- PSO 1 Develop ability to understand and analyze industrial metallurgy engineering data and provide the appropriate solutions to engineering problems.
- PSO 2 Impart theoretical & practical skills in various metallurgical processes, failure analysis, testing etc. to optimize the industrial procedures to develop the quality & cost effective products.
- PSO 3 Expertise to find out the root cause of real world failures in metallurgical industry and to determine the remaining life of system.
- PSO 4 Emphasis cost effectiveness and environmental safety of the industrial metallurgy field through various dissertation projects.
- PSO 5 Endowed technical competency, ethics, interdisciplinary working skill and contribute society philanthropically.

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering		Academic Year		2020-21					
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Year	I	Core / Elective / Foundation Code: MME2121 Subject: Ceramic Materials		Credits / Hours per week				04		
Semester	I	Year of Introduction: Year of Syllabus Revision:		Maximum Marks / Grade				100		
Mode of Transaction		Lectures								
Course Outcome (CO) CO1 Introduction to ceramics & study of raw materials of ceramics and ceramic forming processes. CO2 Study of oxide structures, silicate structures, non crystalline solids, silicate glasses and non silicate glasses. CO3 Understand phase diagram of two component systems, three and multi component ceramic & basic knowledge about microstructure examination of ceramics. CO4 Application of ceramic Tools. CO5 Study of various electronic ceramics, dielectricceramics, piezoelectricceramics, magnetic ceramic, semiconductive ceramics & various coating of ceramics										
Unit No.	Topic/Unit		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurs hip (Ent)/ Skill	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G) developmental	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and

							Development (SD)	needs	Professional Ethics (PE)
1	Introduction: Traditional ceramics, modern ceramics and role of ceramic in modern engineering.	03	6	1,2,3,4	CO1	1, 2, 3	Emp, Ent, SD	G	HV,PE
2	Study of raw materials like clay minerals, talc, silica and silicates, refractory and other raw materials. An overall study of ceramic forming processes. Pressing, extrusion, slip casting, injection moulding, glass forming methods, etc.	07	14	2,3,4,5	CO1	3, 4			
3	Study of oxide structures, silicate structures and clays. Study of non-crystalline solids. Silicate glasses and non-silicate glasses.	06	12	2,3,4,5, 6	CO2	4, 5			
4	Study of phase diagrams of two component systems. Three component and multi-component ceramic systems with special reference to Al ₂ O ₃ -SiO ₂ , Al ₂ O ₃ -MgO-SiO ₂ systems. Study of glasses and metastable phases.	08	16	2,3,4,5, 6	CO3	4, 5			
5	Basic aspects of microstructural examination of ceramic. Properties of ceramics. Thermal properties, electrical properties, dielectric and magnetic properties, mechanical properties.	08	16	1,2,3,4, 5,6	CO3	3, 5			
6	Application as cemented carbide tools, silicon nitride tools, sialon tools, alumina tools, Silicon carbide tools, etc.	06	12	2,3,4	CO4	2, 4			
7	Study of various types of electronic ceramics. Dielectric ceramics, piezoelectric ceramics. semiconductive ceramic and magnetic ceramics.	06	12	2,3,45	CO5	3, 5			
8	Study of ceramic coatings and advances in high temperature ceramics, ceramic composites.	06	12	1,2,4,5, 3	CO5	3, 5			
	TOTAL	50 Hours	100%						
Reference Books									
1	Introduction to ceramics, W. D. Kingery. John Wiley Sons.								
2	Engineering Applications of Ceramic Materials, M. M. Schwartz, ASM Publication.								
3	Modern Ceramic Engineering, Properties\, processing and use in design, by D. W. Richerson, Marcel & Dekker Inc., New York, 1982								

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ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme											
Year	I	Core-/ Elective / Foundation Code: Subject: Energy Economy and Waste Management				Credits / Hours per week		04			
Semester	I	Year of Introduction: Year of Syllabus Revision:				Maximum Marks / Grade		100			
Mode of Transaction		Lectures									
Course Outcome (CO) CO1 To learn about energy conservation in industries CO2 Understand application , principles and energy balance for metallurgical processes CO3 Characterization of water waster , slags etc. during metallurgical products CO4 To evaluate energy consideration for various metallurgical industries CO5 Energy consideration for extraction of iron ore CO6 Learn about metallurgical waster and recovery management											
Unit No.	Topic/Unit			Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values

							Development (SD)	developmental needs	(HV)and Professional Ethics (PE)
1	Energy conservation in metallurgical industries	04	8	1,2,3	CO1	1,2,3	Emp, Ent, SD	G	PE,HV,ES
2	Application of thermodynamic principles and energy balance.	05	10	3,4	CO2	2,3,4			
3	Conventional and non-conventional energy sources and their applications in metallurgical industries.	08	16	3,4,5	CO2	2,3			
4	Energy conservation and recovery	05	10	1,2,3	CO4	2,3			
5	Energy consideration in some major metallurgical industries.	08	16	4,5,6	CO4	2,3,4			
6	Energy consideration in electrometallurgical extraction processes, energy audit	07	14	4,5,6	CO5	2,3			
7	Metallurgical waste and their classifications	06	12	2,3,4	CO6	1,5			
8	Characterization of waste water, gases & slags and their means of recovery.	07	14	5,6	CO6	4			
	TOTAL	50 Hours	100%						
Reference Books									
1	Energy Management in Iron & Steel Works – The Iron & Steel Institute, 1968								
2	New Energy Saving Technologies: Operating Experience – I. I. S. I.								
3	Statistics on Energy in Steel Industry – I.I.S.I								
4	Steel & Energy – I. I. S. I								
5	National Seminar on Specific Energy Consumption in the Iron & Steel Industry 10-12 Dec. 1982 Jamshedpur, I.I. M								
6	Symposium on Exploring Alternative Source of Energy conservation in Steel Industry 14-14 Dec. 1984 Bhadravati, I. I. M.								
7	Seminar on Energy Conservation In Steel Industry, 14 Dec. 1991, Bhilai, I. I. M.								

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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engg	Academic Year	2020-21	
ME (Metallurgical & Materials)(Industrial Metallurgy)Regular Programme				
Year	I	Core / Elective / Foundation Code: Subject: High Temperature Materials	Credits / Hours per week	04 Hrs/ week
Semester	I	Year of Introduction: Year of Syllabus Revision:	Maximum Marks / Grade	100 Marks
Mode of Transaction		Lectures		
Course Outcome (CO) CO1 To Understand about high temperature performing materials CO2 To get knowledge about high temperature materials classifications, advantages and limitations. CO3 To learn different compositions of various high temperature alloys CO4 To learn about super alloys CO5 To understand the performance of such materials at elevated temperature CO6 To study different composite materials performing high temperature duties CO7 To get idea about high temperature coatings				

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV) and Professional Ethics (PE)
1	Definition of high temperature materials. Types of high temperature materials such as metals and alloys, refractories & ceramics, composites and coatings, etc. Scope and limitations of each type. Property requirements for high temperature materials.	8	16	1,2	CO1	1,2,3	EMP, ENT, SD	G	ES, PE
2	Metals and alloys for high temperature application. Heat resisting alloys, their composition, properties and applications. Stainless steels, their composition, properties and applications as high temperature materials.	6	12	1,2	CO2, 3	2,3,4			
3	Superalloys: Nickel, cobalt and iron base superalloys. Their typical compositions, properties and applications. Strengthening mechanism for super alloys. Oxide-dispersion strengthened superalloys.	6	12	1,2,3, 4	CO4	2,3			
4	Study of refractory metals like tungsten, molybdenum, vanadium & tantalum and their compounds for high temperature application.	8	16	1,2,3	CO5	2,3			
5	Brief review of composition, properties and applications of various acid, basic & neutral refractories. Basic aspect of properties of refractories such as refractoriness, spalling, resistance, thermal shock resistance, corrosion etc.	8	16	1,2,3, 4,5	CO3	2,4,5			
6	Metal-matrix composites: Study of aluminium, magnesium & titanium matrix composites reinforced with SiC or Al ₂ O ₃ particulate or fibres.	5	10	1,2,3	CO6	5			

7	Ceramic-matrix composites as high temperature materials. Whisker reinforced and long fibre perform composites with alumina, silicon nitride, silica or zirconia as matrix.	5	10	1,2,3	CO6	2,5			
8	Metallic and ceramic coatings as thermal barriers	4	8	1,2,3	CO7	3			
	TOTAL	50 Hours	100%						

Reference Books

1	Research and development of high temperature materials for industry. Ed. E. Bullock, Elsevier Applied Science, New York, (1989).
2	Source book on 'Materials for Elevated Temperature Applications' ASM Publication, (1979).
3	High Temperature Materials and Technology, Campbell and Sherwood, John Willey & Sons, (1967).
4	Introduction to Ceramics, W.D. Kingery, John Willey & Sons, (1976).
5	P. Ramakrishnan, Powder Metallurgy & Related High Temperature Materials, Oxford & IBH Publishers, New Delhi.

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		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering				Academic Year				2020-21		
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme												
Year		I	Core / Elective / Foundation Code: Subject: Process Modeling				Credits / Hours per week				04	
Semester		I	Year of Introduction: Year of Syllabus Revision:				Maximum Marks / Grade				100	
Mode of Transaction			Lectures and Tutorials									
Course Outcome (CO) CO1 Understand basics of computational methods CO2 Learn basics of modeling CO3 Learn various types of modeling CO4 Applications of modeling CO5 Learn characterization and case studies												
Unit No.	Topic/Unit			Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and	

									Professional Ethics (PE)
1	Basics of computational methods: Finite difference method and finite element analysis. Solution of ordinary and partial differential equations. Integral transformations	05	10	1,2,3	CO1	1,2,3	Emp, Ent, SD	G	G, ES, HV, PE
2	Basics of modeling: Classification, functions, limitations and inter-relationship of different types of models	05	10	1,2,3,4,5	CO2	2,3,4			
3	Physical modeling: Geometric, kinematic, dynamic, thermal and chemical similarity. Semi rigorous models	05	10	1,2,3,4	CO3	2,3			
4	Model materials and measurement techniques	05	10	1,2	CO3	4, 5			
5	Mathematical modeling: Types, role in process analysis and development	05	10	1,2,3,4	CO3	2,3,4			
6	Steps: Preparation, mathematical formulation, validation, application	05	10	1,2,3	CO3	2,3			
7	Applications: Application of mathematical models to control metallurgical processes. Static and dynamic models	05	10	3,4,5	CO4	5			
8	Characterization of structure and properties. Development and execution of illustrative computer programs	05	10	3,2,4,5,	CO5	1,2,3			
9	Case studies in process metallurgy topics	05	10	4,5,6	CO5	5			
10	Case studies in physical metallurgy topics	05	10	4,5,6	CO5	2,3,4			
	TOTAL	50 Hours	100%						
Reference Books									
1	The Mathematical and Physical Modeling of Primary Metals Processing Operations by J.S. Szekeley, J.W. Evans and J.K. Brimacombe – Wiley								
2	An introduction to Numerical computations by S. Yakowitz and Szidarovszky – Maxwell Macmillian								
3	Numerical Methods for Engineers by S.C. Chopra and R.P. Canale – Mc Graw Hill.								
4	Numerical Recipes by W.H. Press, B.P. Flannery, S.A. Teukolsky and W.D. Vetterling.								
5	Engineering in Process Metallurgy – R.I.L. Guthrie, Oxford, 1989.								

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ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Year		II	Core / Elective / Foundation Code: Subject: Process Modeling Laboratory				Credits / Hours per week		02 (Practical)	
Semester		II	Year of Introduction: NA Year of Syllabus Revision: NA				Maximum Marks / Grade		50 (TW/VIVA)	
Mode of Transaction			Laboratory Experiments, discussion and viva							
No.	Experiment					Contact Hr	Weightage (%)	BT Level	CO	PSO
1	Exp;1					2	15	1,2,3	CO1	1,2,3
2	Exp:2					2	15	2,3	CO2	2,3,4
3	Exp:3					2	15	4	CO3	3,4
4	Exp:4					2	15	4,5	CO4	5
5	Exp:5					2	10	4,6	CO5	1,2
6	Exp:6					2	10	5,6,	CO6	3,4
7	Exp:7					2	10	,4,5,6	CO6	4,5
8	Tutorial : 1					2	5	2,3,4	CO6	5
9	Tutorial :2					2	5	3,4,5	CO6	1,4

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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering					Academic Year			2020-21		
ME (Metallurgical & Materials)(Industrial Metallurgy) Regular Programme											
Year	I	Code: MME2106 Subject: Experimental Techniques in Metallurgy			Credits / Hours per week				04 Hrs/ week		
Semester	I	Year of Introduction: Year of Syllabus Revision:			Maximum Marks / Grade				100 Marks		
Mode of Transaction		Lectures, PPT, Tutorials, Factory Visit, Videos etc									
Course Outcome (CO) CO1 Importance of the subject CO2 Classification of various defects which should understand by engineers. CO3 Microstructural characterization techniques CO4 Material evaluation CO5 Mechanical characterization techniques CO6 Coating evaluation											
Unit No.	Topic/Unit			Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Special techniques in metallography:			8	16	1,2,3,	CO1	1			

	Polarized beam, phase contrast, interferometry, bright field, dark field and oblique illumination, principles of above techniques and their applications.			4,5			EMP, ENT, SD	G	ES
2	Quantitative metallurgy and image analysis, applications and developments for quantitative image analysis in metallurgy.	7	14	1,2,3, 4,5	CO2, CO6	2			
3	X- Ray diffractometry such as phase analysis and structure analysis.	4	8	1,2	CO3	3			
4	Electron microscopy, specimen preparation, image formation, application of electron microscopy techniques. Scanning Electron Microscopy, EDS and WDS.	8	16	1,2,3, 4,5	CO4	4, 5			
5	High Resolution Transmission Electron Microscopy and Electron Probe Micro Analysis.	5	10	1,2,3, 4,5	CO5	5			
6	Thermal Analysis: DTA, TG, & D.S.C. and Thermomechanical analysis, principles and applications.	6	12	1,2,3, 4,5	CO4, CO5, CO6	4, 5			
7	Physicochemical properties of liquid metals and alloys such as viscosity, surface tension and electrical conductivity.	6	12	1,2,3, 4	CO4, CO5	4, 5			
8	Chemical analysis using Emission Spectroscopy, XRF and ASS.	6	12	1,2,3, 4,5	CO4, CO5	4, 5			
	TOTAL	50 Hours	100%						
Text / Reference Books									
1	Experimental Techniques in Physical Metallurgy, V.T. Cherepin& A.K. Malik, I.I.T., Bombay.								
2	Techniques of Metals Research Vol.-I, Vol.-II, Bunshah Inter Science Publication.								
3	Thermal Analysis by Bernhard Wiindrelich Academic Press.								
4	Image Analysis & Metallography. (Microstructural Science Vol.-17) ASTM 1989.								

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ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Year		I	Code: MME2106L Subject: Experimental Techniques in Metallurgy Laboratory				Credits / Hours per week		02Hrs/ week	
Semester		II	Year of Introduction: Year of Syllabus Revision:				Maximum Marks / Grade		50 Marks	
Mode of Transaction			Lectures, PPT, Tutorials, Factory Visit, Videos etc							
No.	Experiment					Contact Hr	Weightage (%)	BT Level	CO	PSO
1	Exp;1					2	15	1,2,3	CO1	1,2,3
2	Exp:2					2	15	2,3	CO2	2,3,4
3	Exp:3					2	15	4	CO3	3,4
4	Exp:4					2	15	4,5	CO4	5
5	Exp:5					2	10	4,6	CO5	5
6	Exp:6					2	10	5,6,	CO6	3,4
7	Exp:7					2	10	,4,5,6	CO6	4,5
8	Tutorial : 1					2	5	2,3,4	CO6	5
9	Tutorial :2					2	5	3,4,5	CO6	4,5

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ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Year	I	Core / Elective / Foundation Code: MME2107 Subject: Iron and Steel Technology		Credits / Hours per week				04		
Semester	I	Year of Introduction: Year of Syllabus Revision:		Maximum Marks / Grade				100		
Mode of Transaction		Lectures								
Course Outcome (CO) CO1 Learn the Recent developments in iron and steel making CO2 Understand the thermodynamics behind the reactions in blast furnace CO3 Learn oxygen steel making CO4 Understand the Deoxidation and inclusion shape control. CO5 Learn the Continuous casting of steel CO6 Understand the Energy aspects in iron and steel making										
Unit No.	Topic/Unit		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurs hip (Ent)/ Skill Development	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional

							(SD)		Ethics (PE)
1	Recent developments in iron and steel making. Blast furnace reactions and process dynamics, advances in agglomeration.	6	12	1,2	1	1,2,3	Emp, Ent, SD	G	
2	Thermodynamics of Fe-O, C-O-Fe and C-O-Fe-H ₂ systems and kinetics of iron oxide reduction, gas-solid and slag-metal reactions, application of physical chemistry in iron and steel making. C-O, Si-O, Mn-O reactions, reactions of S and P, sulphide and phosphate capacities.	8	16	2,3	2	2,3,4			
3	Direct reduction: Gas-based and coal-based, reactions in Midrex / HyL processes, rotary kiln processes and operational difficulties, smelting reduction-COREX process.	6	12	2,3	2	2,3			
4	Oxygen steelmaking: Design parameters for vessel and lance, material and heat balances, Electric arc furnace process, design and recent developments.	6	12	1,2,3	3	5			
5	Secondary and alloy steel making principles and practices, ladle metallurgy, vacuum degassing and electro-slag remelting.	6	12	1,2,3	3	2,3,4			
6	Deoxidation and inclusion shape control.	6	12	1,2,3	4	2,3			
7	Continuous casting of steel: Solidification mechanisms and structure.	6	12	1,2,3	5	5			
8	Energy aspects in iron and steel making, pollution and its control.	6	12	1,2,3	6	4. 5			
	TOTAL	50 Hours	100%						

Reference Books

1	Iron Making and steel making: Theory & Practice – A Ghosh and A Chatterjee, Prentice-Hall of India Pvt. Ltd., New Delhi.
2	Electro-metallurgy of Steel & Ferro Alloys, Vol. I & II, E.P. Edneral, MIR Publication, Moscow.
3	Making, Shaping and Treating of Steel, (Vol. I : Iron making, II-Steel Making) 11 th Edition, AISE Steel Foundation, 1999, Pittsburgh.
4	Secondary Steel Making: Principle and Application, A Ghosh, CRC Press.
5	Electric Furnace Steel Making, Ed C R Taylor, AIME, Iron & Steel Society.
6	Principle of Secondary Processing & Casting of Liquid Steel, A Ghosh, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

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ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Part	I	Core / Elective / Foundation Code: MME2108 Subject: Metal Casting and Solidification		Credits / Hours per week				04		
Semester	I	Year of Introduction: Year of Syllabus Revision:		Maximum Marks / Grade				100		
Mode of Transaction		Lectures and Tutorials								
Course Outcome (CO) CO1 Learn Moulding materials: Properties, preparation & testing CO2 Learn about various production techniques CO3 Understand Crystallization & the development of cast structure CO4 Learn the Liquid metals and gating & feeding of castings CO5 Learning the casting design CO6 Analysis of casting defects										
Unit No.	Topic/Unit		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurs hip (Ent)/	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human

							Skill Development (SD)	developmental needs	Values (HV) and Professional Ethics (PE)
1	Moulding materials: Properties, preparation & testing: Functional requirements of moulding materials, moulding practice & special requirements of core sands, foundry sands & binders, sand preparation & systems, silica programme.	6	12	1,2	1	1,2,3	Emp, Ent, SD	G	PE,HV,ES
2	Production techniques (I): Manufacture of sand castings, mould production, moulding techniques, cores & core making, melting & casting, finishing operation.	6	12	2,3	2	2,3,4			
3	Production techniques (II): Shell, investment and die casting process, centrifugal casting, other special techniques.	6	12	2,3	2	2,3			
4	Crystallization & the development of cast structure: Crystallization from melt, the structure of castings.	6	12	1,2,3	3	5			
5	Liquid metals and gating & feeding of castings: Fluidity of liquid metals, mould factors in metal flow, the gating of casting. The feeding characteristics of alloys, methods for feeding of castings; design modifications, padding chills & insulation, the feeding of cast irons, solidification modeling.	8	16	1,2	4	2,3,4			
6	Casting design: Preliminary stages & production stages, process & alloy selection, physical design features, quality assessment & control.	6	12	1,2,6	5	2,3			
7	Analysis of casting defects: Categories of defects, gas defects, shrinkage defects, contraction defects, compositional errors & segregation, inclusions & sand defects, shaping faults.	6	12	1,2,4	6	5			
8	Environmental protection, health & safety.	6	12	3,6	5	2, 3, 5			
	TOTAL	50 Hours	100%						
Reference Books									
1	Foundry Technology, P.R. Beeley, Butterworth Publication, 1972.								
2	Cast Iron Technology, Roy Elliot, Butterworth Publication, 1988.								
3	Sand Preparation & Control, W.B. Parks.								
4	Applied Sciences in the Casting of Metals, Ed. K. Strauss, Pergamon Press.								

5	Fundamental of Metal Casting Technology, P.C. Mukherjee, Oxford & I BH Publishing Co., 1979.
6	Foundry Technology Source Book of ASM & AFS, 1982.

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme

Programme Specific Outcome (PSO)

Students will be able to

- PSO 1 Develop ability to understand and analyze industrial metallurgy engineering data and provide the appropriate solutions to engineering problems.
- PSO 2 Impart theoretical & practical skills in various metallurgical processes, failure analysis, testing etc. to optimize the industrial procedures to develop the quality & cost effective products.
- PSO 3 Expertise to find out the root cause of real world failures in metallurgical industry and to determine the remaining life of system.
- PSO 4 Emphasis cost effectiveness and environmental safety of the industrial metallurgy field through various dissertation projects.
- PSO 5 Endowed technical competency, ethics, interdisciplinary working skill and contribute society philanthropically.

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering		Academic Year	2020-21
ME (Metallurgical & Materials)(Industrial Metallurgy) Regular Programme				
Year	I	Core / Elective / Foundation Code: MME2109 Subject: Welding Metallurgy	Credits / Hours per week	04 Hrs/ week
Semester	I	Year of Introduction: Year of Syllabus Revision:	Maximum Marks / Grade	100 Marks
Mode of Transaction		Lectures and Laboratory		
Course Outcome (CO)				
CO1 Understanding the basic concept of weldability				
CO2 Learn about the variousheat flow in welding				
CO3 Understand the metallurgical reactions in weld pool				
CO4 Understand the basic concept solidification in welding				
CO5 Understand the metallurgy of heat affected zone				
CO6 Understand different cracking occurred during and after welding				
CO7 Understand the basic concept of various tests in welding				
CO7 Understand the basic concept of dissimilar metal welding				

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV) and Professional Ethics (PE)
1	Classification and review of welding processes. Concept of weldability. Mechanism and metallurgy of welding in various solid phase welding processes.	6	12	1,2	CO1	1,2,3	Emp, Ent, SD	G	ES, PE
2	Heat flow equation and its refinement, Fundamental of stress development in weldments, distortion and other effects of residual stresses.	6	12	1,2	CO2	2,3,4			
3	Principles of consumable development in welding. Chemistry of slag-metal and gasmetal reaction, Gas flow equation hydrogen in welding. Effect of dilution on chemistry of weld metal.	7	14	1,2,3, 6	CO3	2,3			
4	Metallurgy of weld metal, Mode of solidification and segregation, phase transformation during solidification of steel weld metal.	8	16	1,2,4, 5,6	CO4	5			
5	Metallurgy of heat affected zone- Transformations during heating and cooling cycles, Role of preheating and post heating on metallurgy of weldments of carbon steels and alloys steels.	8	16	1,2,3, 4,5,6	CO5	1,2,4			
6	Mechanism of solidification cracking and its control. Lamella tearing, Strain age embrittlement. Tests for above.	6	12	1,2,3, 4,5	CO6	5			
7	Mechanism of hydrogen induced cracking and its Testing. Fracture toughness of weldments and its testing.	4	8	1,2,3, 4,5	CO7	2,5			
8	Metallurgy of dissimilar metal welds, clad metals etc., Welding metallurgy of various type of cast irons, Metallurgy of repair welding.	5	10	1,2,3, 4,5,6	CO8	4,5			
	TOTAL	50	100%						

		Hours							
Text / Reference Books									
1	Introduction to the Physical Metallurgy of Welding by Kenneth Easterling, Butterworth, 1983.								
2	Metals Handbook, 9th Ed., Vol.-6, Welding Brazing and Soldering, ASM, 1983.								
3	Welding Handbook, 7th Ed., Vol.-1, Fundamentals of Welding, AWS, 1978.								
4	Weldability of Steels, R.D. Stout, Welding Research Council, 1987.								

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering					Academic Year			2020-21		
		ME (Metallurgical & Materials)(Industrial Metallurgy)Regular Programme										
Year		I	Core / Elective / Foundation Code: MME2109L Subject:Welding Metallurgy Laboratory					Credits / Hours per week			02 Hrs/ week	
Semester		I	Year of Introduction: Year of Syllabus Revision:					Maximum Marks / Grade			50 Marks	
Mode of Transaction			Tutorials and Experiments									
No.	Experiment						Contact Hour	Weightage (%)	BT Level	CO	PSO	
1	Introduction to welding and weld joints						2	15	1,2	CO2	4,5	
2	Study and observation of shielded metal arc welding process						2	15	2,4,5	CO1	2,3,4	
3	Study and observation of tungsten arc welding process						2	15	2,4,5	CO1	4, 5	
4	Study and observation of MIG/MAG process						2	15	2,4,5	CO1	4.5	
5	Study and observation of gas welding/ gas cutting						2	10	1,2,3	CO3,C O4	1,2	
6	Microstructure observation of resistance spot welded sampleto measure the ferrite content in ASS welded samples						2	10	1,2,6	CO4,C O6	5	
7	Microstructure observation of various grades of ASS welded samples						2	10	1,2,3	CO1, CO3, CO6	1, 2	
8	Observation of submerged arc welding and electrostatic strip cladding process						2	5	1,2,3,4	CO3,C O4	4,5	
9	Microstructure observation of various welding defects.						2	5	2,3,4	CO4,C O6	5	

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme**Programme Specific Outcome (PSO)**

Students will be able to

- PSO 1 Develop ability to understand and analyze industrial metallurgy engineering data and provide the appropriate solutions to engineering problems.
- PSO 2 Impart theoretical & practical skills in various metallurgical processes, failure analysis, testing etc. to optimize the industrial procedures to develop the quality & cost effective products.
- PSO 3 Expertise to find out the root cause of real world failures in metallurgical industry and to determine the remaining life of system.
- PSO 4 Emphasis cost effectiveness and environmental safety of the industrial metallurgy field through various dissertation projects.
- PSO 5 Endowed technical competency, ethics, interdisciplinary working skill and contribute society philanthropically.

Syllabus of Courses

 सत्यं शिवं सुन्दरम्	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering		Academic Year		2020-21					
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Year	I	Core / Elective / Foundation Code: MME2215 Subject: Corrosion of Metals & Alloys		Credits / Hours per week			04			
Semester	II	Year of Introduction: Year of Syllabus Revision:		Maximum Marks / Grade			100			
Mode of Transaction		Lectures and Tutorials								
Course Outcome (CO) CO1 Understand principle of corrosion & modified Nernst equation, Pourbaix diagrams. CO2 Learn about Activation, Concentration and mixed Polarization & types of inhibitor. CO3 Understand High temperature corrosion and corrosion of Different metal and alloys in water. CO4 Learn about metallic and non metallic coating & testing method of corrosion. CO5 Study of other tests such as Potentiodynamic test,EPR test,AC Impedance test,ASTM 262 test.										
Unit No.	Topic/Unit		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurs hip (Ent)/ Skill	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G) developmental	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and

							Development (SD)	needs	Professional Ethics (PE)
1	Thermodynamics of corrosion, Corrosion principle & modified Nernst's equation, Pourbaix diagrams. Fe-O-H system. Hydrogen & oxygen evolution. Kinetics of electrochemical reaction.	06	12	1,2,3,5,6	CO1	1,2,3	Emp, Ent, SD	G	PE,HV
2	Activation, concentration and mixed polarizations. Mixed potential theory. Anodic and cathodic polarizations	06	12	2,3,4	CO2	2,3,4			
3	Theory of inhibition. Zero charge potential. Electrical double layer. Type of inhibitors. Some corrosion inhibitor examples.	06	12	1,2,4,5	CO2	2,3			
4	High temperature corrosion. Oxidation corrosion with flue gases. Oxides of carbon,sulphur containing gases. Sulphidation, corrosion in air, corrosion by molten salts.	06	12	2,5,6	CO3	2,3			
5	Cooling water. Quality of natural water. Formation of deposits. Corrosion of different metals and alloys in water. Deaeration, deoxygenation.	06	12	4,5,6	CO3	2,3,4			
6	Methods of combating corrosion with special reference to metallic and non-metallic coatings (anodizing, phosphating and chromating). Improvement in design. Cladding Advances in cathodic and anodic protection techniques. Corrosion resistant alloys in brief (Austenitic, martensitic & ferritic stainless steel, Nickel alloys, copper alloys & titanium alloys).	10	20	1,2,3,4,6	CO4	2,3			
7	Corrosion testing methods. Weight loss method and its limitation.	04	8	2,3,4,5,6	CO4	4,5			
8	Other Practices: Electro chemical methods. Accelerated tests such as potentiodynamic test and EPR test. AC Impedance Methods. ASTM A262 practices A-E, ASTM tests for pitting / crevice and galvanic corrosion.	06	12	2,3,5,6	CO5	5			
	TOTAL	50 Hours	100%						

Reference Books

1	Corrosion Engineering – Mars G. Fontana and Norbert D. Green, Mcgraw-Hill International Book Company, New Delhi.
2	Corrosion and Corrosion Control – An Introduction to Corrosion Science & Engineering – Herbert H. Uhlig. John Wiley & Sons Inc., New York.
3	Corrosion – Vol. 1 & 2 – L.L. Shreir, R.A. Jarman& G.T. Burstein, Butterworth Heinemann, U.K.

4	Conversion coating – anodizing, phosphating &chromatizing by Rajgopalan& K.I. Vasu, Tata McGraw-Hill Publishing Co. Ltd., New Delhi
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		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering				Academic Year		2020-21		
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Year	I	Core / Elective / Foundation Code: MME2215L Subject:Corrosion of Metals & AlloysLaboratory				Credits / Hours per week		02(Practical)		
Semester	II	Year of Introduction: Year of Syllabus Revision:				Maximum Marks / Grade		50 (TW/VIVA)		
Mode of Transaction		Laboratory Experiments, discussion and viva								
No.	Experiment					Contact Hr	Weightage (%)	BT Level	CO	PSO
1	Ex – Corrosion rate measurement by weight loss method					2	15	1,2	1,2,3	1,2,3,4
2	Ex – Measurement of electrode potential by different media					2	15	2,3	3	2,3
3	Ex – Galvanic corrosion measurement					2	15	2,3	3,4,5	5
4	Ex- Electroplating					2	15	1,2,3	1,2,3	2,3,4
5	Ex – Copper Powder production					2	10	1,2,3	1,2,3,4,5	2,3
6	Ex – Anodizing of Aluminium					2	10	1,2,3	1,2,3,4,5	4,5
7	Ex – Study of anodic dissolution					2	10	1,2	1,2,3,4,5	2,3,4
8	Ex- Potentiodynamic testing					2	10	2,3	1,2,3,4,5	2,3,4

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme

Programme Specific Outcome (PSO)

Students will be able to

- PSO 1 Develop ability to understand and analyze industrial metallurgy engineering data and provide the appropriate solutions to engineering problems.
- PSO 2 Impart theoretical & practical skills in various metallurgical processes, failure analysis, testing etc. to optimize the industrial procedures to develop the quality & cost effective products.
- PSO 3 Expertise to find out the root cause of real world failures in metallurgical industry and to determine the remaining life of system.
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- PSO 5 Endowed technical competency, ethics, interdisciplinary working skill and contribute society philanthropically.

Syllabus of Courses

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering		Academic Year			2020-21			
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Year	I	Core / Elective / Foundation Code: MME2223 Subject: Failure Analysis		Credits / Hours per week			04			
Semester	II	Year of Introduction: Year of Syllabus Revision:		Maximum Marks / Grade			100			
Mode of Transaction		Lectures and Tutorials								
Course Outcome (CO) CO1 Understanding the Fundamentals of failure analysis CO2 Learn various types of fractures and its characteristic CO3 Learn about the high temperature failures CO4 Understand the fatigue fracture and corrosion fatigue CO5 Understand wear failure CO6 Defects in materials and their role in failure of engineering components										
Unit No.	Topic/Unit		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human

2	Understanding How Components Fail – Donald J. Wulpi, ASM Publication, Ohio.
3	Handbook on Fractography, Vol.-10, 8 th Edition, ASM Publication, Ohio.
4	Defects and Failure of Metals – Polunskin..

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering				Academic Year		2020-21		
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Year		I	Core / Elective / Foundation Code: MME2223L Subject: Failure Analysis Laboratory				Credits / Hours per week		02 (Practical)	
Semester		II	Year of Introduction: NA Year of Syllabus Revision: NA				Maximum Marks / Grade		50 (TW/VIVA)	
Mode of Transaction			Laboratory Experiments, discussion and viva							
No.	Experiment				Contact Hr	Weightage (%)	BT Level	CO	PSO	
1	Exp:1				2	15	1,2,3	CO1	1,2,3	
2	Exp:2				2	15	2,3	CO2	2,3,4	
3	Exp:3				2	15	4	CO3	3,4	
4	Exp:4				2	15	4,5	CO4	4,5	
5	Exp:5				2	10	4,6	CO5	5	
6	Exp:6				2	10	5,6,	CO6	3,4	
7	Exp:7				2	10	,4,5,6	CO6	4,5	
8	Tutorial : 1				2	5	2,3,4	CO6	5	
9	Tutorial :2				2	5	3,4,5	CO6	3,5	

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme

Programme Specific Outcome (PSO)

Students will be able to

- PSO 1 Develop ability to understand and analyze industrial metallurgy engineering data and provide the appropriate solutions to engineering problems.
- PSO 2 Impart theoretical & practical skills in various metallurgical processes, failure analysis, testing etc. to optimize the industrial procedures to develop the quality & cost effective products.
- PSO 3 Expertise to find out the root cause of real world failures in metallurgical industry and to determine the remaining life of system.
- PSO 4 Emphasis cost effectiveness and environmental safety of the industrial metallurgy field through various dissertation projects.
- PSO 5 Endowed technical competency, ethics, interdisciplinary working skill and contribute society philanthropically.

Syllabus of Courses

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering			Academic Year			2020-21			
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme											
Year		I	Core- / Elective / Foundation Code: Subject: Fracture Mechanics			Credits / Hours per week			04		
Semester		II	Year of Introduction: Year of Syllabus Revision:			Maximum Marks / Grade			100		
Mode of Transaction			Lectures and Tutorials								
Course Outcome (CO) CO1 Understanding conventional design concept CO2 Learn mechanics of fracture and types of fracture CO3 Understanding designing and testing for fracture resistance CO4 Learn microscopic aspects of plastic deformation CO5 Learning the physical meaning of fracture toughness CO6 Learning fracture under different conditions											
Unit No.	Topic/Unit			Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship	Relevance to Local (L)/ National (N)/ Regional(R)/	Relation to Gender (G), Environment and Sustainability (ES), Human Values

							(Ent)/ Skill Development (SD)	Global (G) developmenta l needs	(HV)and Professional Ethics (PE)
1	Conventional design concepts and their relation to occurrence of fracture, inadequacies of conventional design concepts.	06	12	1,2	CO1	1,2,3	Emp, Ent, SD	G	ES,
2	The mechanics of fracture, types of fracture, types of fracture under uniaxial testing loading, the mechanics of elastic crack propagation, the mechanics of plastically induced fracture, physical significance of fracture toughness.	08	16	1,2,3	CO2	3,4			
3	Designing and testing for fracture resistance, principles of fracture safe design, visual analysis of fracture, testing procedures, time dependent fracture.	06	12	2,3,4	CO3	4,5			
4	Microscopic aspects of plastic deformation and crack propagation, cleavage crack propagation (Mode I), normal rupture and ductile rupture.	06	12	2,3,4	CO4	4,5			
5	Cleavage crack nucleation and ductile to brittle transition, flaw- free low- strength materials.	06	12	1,2,3	CO4	3,5			
6	Relation between macroscopic and microscopic aspects of plane strain fracture, physical meaning of fracture toughness.	06	12	1,2,3	CO5	2,4			
7	Fracture under cyclic loading, effect of environment and temperature on fatigue.	06	12	1,2,3	CO6	3,5			
8	Fracture under static loading, creep, S.C.C., hydrogen embrittlement, fracture of steels, non-ferrous metals and composite materials as examples.	06	12	1,2,6	CO6	3.4.5			
	TOTAL	50 Hours	100%						
Reference Books									
1	An Introduction to Fracture Mechanics-Tetelman and Mc Eliue.								
2	Fatigue and Fracture Control in Structures-Rolfe.								

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering				Academic Year		2020-21			
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Year	I	Core/ Elective / Foundation Code: Subject : Fracture Mechanics Laboratory				Credits / Hours per week		02 (Practical)		
Semester	II	Year of Introduction: Year of Syllabus Revision:				Maximum Marks / Grade		50 (TW/VIVA)		
Mode of Transaction		Laboratory Experiments, discussion and viva								
No.	Experiment					Contact Hr	Weightage (%)	BT Level	CO	PSO
1	Exp;1					2	15	1,2,3	CO1	1,2,3
2	Exp:2					2	15	2,3	CO2	2,3,4
3	Exp:3					2	15	4	CO3	3,4
4	Exp:4					2	15	4,5	CO4	3,4
5	Exp:5					2	10	4,6	CO5	4,5
6	Exp:6					2	10	5,6,	CO6	3,4
7	Exp:7					2	10	,4,5,6	CO6	4,5
8	Tutorial : 1					2	5	2,3,4	CO6	1-5
9	Tutorial :2					2	5	3,4,5	CO6	2,4,5

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme**Programme Specific Outcome (PSO)**

Students will be able to

- PSO 1 Develop ability to understand and analyze industrial metallurgy engineering data and provide the appropriate solutions to engineering problems.
- PSO 2 Impart theoretical & practical skills in various metallurgical processes, failure analysis, testing etc. to optimize the industrial procedures to develop the quality & cost effective products.
- PSO 3 Expertise to find out the root cause of real world failures in metallurgical industry and to determine the remaining life of system.
- PSO 4 Emphasis cost effectiveness and environmental safety of the industrial metallurgy field through various dissertation projects.
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Syllabus of Courses

 सत्यं शिवं सुन्दरम्	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering		Academic Year	2020-21
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme				
Year	I	Core / Elective / Foundation Code: Subject: Industrial Costing	Credits / Hours per week	04
Semester	II	Year of Introduction: Year of Syllabus Revision:	Maximum Marks / Grade	100
Mode of Transaction		Lectures and Tutorials		
Course Outcome (CO)				
CO1 Classify ferrous metals and alloys.				
CO2 Describe the different methods of processing of iron ores.				
CO3 Enumerate modern trends in iron making blast furnace.				
CO4 Explain brief principles of alternative methods and their advantages and limitations.				
CO5 To learn about Environment, safety and conservation of energy in iron making				
CO6 Understanding the process variables to enhance the productivity and efficiency of the Blast Furnace				

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV) and Professional Ethics (PE)
1	Introduction to costs and its impact on firm operation. Review of costing method, meaning of cost, direct and indirect cost, overheads and their allocation, short run and long run costs, incremental & sunk costs.	06	12	1,2,3	CO 1	1,2,3	Emp, Ent, SD	G	ES,PE
2	Conceptual difference in cost reports & economic analysis: Emphasis on future costs, depreciation, capital gains & losses, current & historic costs, value of currency & impact of inflation inventory evolution.	08	16	2,3,4	CO2	2,4			
3	Cost analysis: Decision making costs & cost reduction. Cost & output rate, cost & size of the plant, concept of value addition, impact of technology, prices of input factors.	06	12	2,3,4,5	CO2	1,2,3			
4	Lot size, efficiency, value engineering, inventory costs, cost of environmental protection, cost of quality.	04	8	2,3	CO3	2,3,5			
5	Project costing & analysis: Capital costs & their estimation, Ratio estimates, capacity ratio exponents, computer analysis, accurate cost estimation.	08	16	1,2,3	CO3	2,3,4			
6	Estimation of manufacturing costs: Direct costs, overheads, interest, other costs. Standard costing	06	12	2,3,4	CO6	2,3			
7	Profitability analysis: Return on investment, pay back period, net present value, internal rate of return. Monte Carlo method	08	16	2,4,5	CO3	5			
8	Capital rationing.	04	8	1,2,3	CO5	1,4,5			
	TOTAL	50 Hours	100%						

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering				Academic Year		2020-21		
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Year		I	Core / Elective / Foundation Code: Subject: Industrial Costing Laboratory				Credits / Hours per week		03 (Practical)	
Semester		II	Year of Introduction: Year of Syllabus Revision:				Maximum Marks / Grade		50 (TW/VIVA)	
Mode of Transaction			Laboratory Experiments, discussion and viva							
No.	Experiment					Contact Hr	Weigh tag e (%)	BT Level	CO	PSO
1	Exp:1					2	15	1,2,3	CO1	1,2,3
2	Exp:2					2	15	2,3	CO2	2,3,4
3	Exp:3					2	15	4	CO3	3,4
4	Exp:4					2	15	4,5	CO4	5
5	Exp:5					2	10	4,6	CO5	3,4
6	Exp:6					2	10	5,6,	CO6	3,4
7	Exp:7					2	10	4,5,6	CO6	4,5
8	Tutorial : 1					2	5	2,3,4	CO6	5
9	Tutorial :2					2	5	3,4,5	CO6	3,5

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme

Programme Specific Outcome (PSO)

Students will be able to

- PSO 1 Develop ability to understand and analyze industrial metallurgy engineering data and provide the appropriate solutions to engineering problems.
- PSO 2 Impart theoretical & practical skills in various metallurgical processes, failure analysis, testing etc. to optimize the industrial procedures to develop the quality & cost effective products.
- PSO 3 Expertise to find out the root cause of real world failures in metallurgical industry and to determine the remaining life of system.
- PSO 4 Emphasis cost effectiveness and environmental safety of the industrial metallurgy field through various dissertation projects.
- PSO 5 Endowed technical competency, ethics, interdisciplinary working skill and contribute society philanthropically.

Syllabus of Courses

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering				Academic Year				2020-21		
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme												
Year		I	Core / Elective / Foundation Code: Subject: Quality Control Techniques				Credits / Hours per week				04	
Semester		II	Year of Introduction: Year of Syllabus Revision:				Maximum Marks / Grade				100	
Mode of Transaction			Lectures and Tutorials									
Course Outcome (CO) CO1 Understand the basics of quality CO2 Learn various examples and case studies CO3 Understand orthogonal arrays and optimization parameters CO4 Learn Factorial experiments and fractional factorial designs. CO5 Learn Testing adequacy of model. Testing significance of coefficients. CO6 Understand Process control using mathematical model, control chart.												
Unit No.	Topic/Unit				Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values

							Development (SD)	developmental needs	(HV)and Professional Ethics (PE)
1	The meaning of quality. Goalpost philosophy, comparison of philosophies, case study, concept of T.Q.M. & ISO 9000	06	12	1,2,3,4	CO1	1,2,3	Emp, Ent, SD	G	
2	Analysis of variance (ANOVA): Understanding variation, No-way Anone, one way Anone, Two-way Anova, Three-way Anova with examples and case studies, critique of the F test.	06	12	2,3,4,5	CO1	3,4			
3	Orthogonal Arrays: Test strategies, steps in designing conducting and analyzing an equipment, examples and experiments and fractional factorial designs	08	16	2,3,4,5	CO2	4			
4	Optimization parameters and selection of model, step by step principle, polynomial models.	06	12	1,2,3,4,5	CO2	4,5			
5	Factorial experiments and fractional factorial designs.	06	12	2,3,4,5	CO3	3,5			
6	Processing of experimental results, method of least squares, regression analysis	06	12	1,2,3	CO4	2,4			
7	Testing adequacy of model. Testing significance of coefficients.	06	12	1,2,3,4	CO5	3,4			
8	Process control using mathematical model, control chart.	06	12	2,3,4,6	CO6	2,5			
	TOTAL	50 Hours	100%						
Reference Books									
1	Statistical methods for Engineers & Scientists, Robert M. Bethea, B. S. Duran & T. L. Bollion, Marcel Dekker Inc. USA, 1975.								
2	Taguchi Techniques for Quality Engineers, Phillip J. Ross, 1990								
3	Design & Analysis of Experiment, M. N. Das, N. C. Giri, Wiley Eastern Ltd., 1988								
4	Design of Experiments to find optimal conditions, Mir Publication, 1975.								

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering			Academic Year		2020-21			
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Year		I	Core / Elective / Foundation Code: Subject: Quality Control Techniques Laboratory			Credits / Hours per week		02 (Practical)		
Semester		II	Year of Introduction: Year of Syllabus Revision:			Maximum Marks / Grade		50 (TW/VIVA)		
Mode of Transaction			Laboratory Experiments, discussion and viva							
No.	Experiment					Contact Hr	Weightage (%)	BT Level	CO	PSO
1	Exp:1					2	15	1,2,3	CO1	1,2,3
2	Exp:2					2	15	2,3	CO2	2,3
3	Exp:3					2	15	3,4	CO3	3,4,5
4	Exp:4					2	15	4,5	CO4	3,4
5	Exp:5					2	10	5,6	CO5	3,4,5
6	Exp:6					2	10	4,5	CO6	3,4,5,
7	Tutorial :1					2	10	5,6	CO2	5
8	Tutorial : 2					2	10	4,5,6	CO3	4,5

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme**Programme Specific Outcome (PSO)**

Students will be able to

- PSO 1 Develop ability to understand and analyze industrial metallurgy engineering data and provide the appropriate solutions to engineering problems.
- PSO 2 Impart theoretical & practical skills in various metallurgical processes, failure analysis, testing etc. to optimize the industrial procedures to develop the quality & cost effective products.
- PSO 3 Expertise to find out the root cause of real world failures in metallurgical industry and to determine the remaining life of system.
- PSO 4 Emphasis cost effectiveness and environmental safety of the industrial metallurgy field through various dissertation projects.
- PSO 5 Endowed technical competency, ethics, interdisciplinary working skill and contribute society philanthropically.

Syllabus of Courses

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering			Academic Year			2020-21			
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme											
Year	I	Core / Elective / Foundation Code: MME2212 Subject: Heat Treatment Practices			Credits / Hours per week			04			
Semester	II	Year of Introduction: Year of Syllabus Revision:			Maximum Marks / Grade			100			
Mode of Transaction		Lectures and Tutorials									
Course Outcome (CO) CO1 Learn about isothermal transformation of austenite to pearlite, bainite & martensite & application of structural steel. CO2 Understand objective and uses of surface hardening of steels. CO3 Study of heat treatment process of steel & heat treatment process for die and tool steel. CO4 Study of heat treatment of cast iron and non ferrous alloys. CO5 Learn about choice of heat treatment equipment such as design of heat treatment furnace and bulk steel production.											
Unit No.	Topic/Unit			Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurs hip (Ent)/ Skill	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G) developmental	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and

							Development (SD)	needs	Professional Ethics (PE)
1	Theory of heat treatment of steels: Formation of austenite. Isothermal transformation of austenite to pearlite, bainite and martensite. Hardenability. Thermal effects. Volume changes and related stress accompanying transformation. Tempering of martensite. Austempering and martempering.	06	12	1,2,3,4,5,6	CO1	1,2,3	Emp, Ent, SD	G	PE,SD,ES
2	Steels for structural applications: Steels not heat-treated to martensite state. Hardenable carbon steels and alloy steels. Super strength steels for aerospace use. Vacuum processed steels.	06	12.	2,3,4,6	CO1	3,4			
3	Surface hardening of steels: Objectives and uses of surface hardening. Objectives and uses of surface hardening. Case hardening of steels. Finishing operations after heat treatment. Control of heat-treating processes.	06	12	1,2,3,4,5,6	CO2	3,4			
4	Heat treatment process: Operations involved in the heat treatment of hot rolled, cold drawn and cold rolled steels. Heat treatment of machine parts. Heat treatment of steel castings, forging of shaft and axles. Heat treatment of springs and gears.	06	12	2,3,5,6	CO3	4,5			
5	Heat treatment of tool and die steels: Principles of heat treatment of low alloy tool steels. Tungsten chisel steel. Non-tempering chisel steel. Semi high-speed steel. Graphite tool steels. Free- machining tool steels. Oil hardening cold worked die steels. Air hardening cold work die steels. Special wear resistance cold work die steels. Hot work die steels. High speed steels.	09	18	1,2,3,5	CO3	3			
6	Heat treatment of cast irons: Heat treatment of gray iron castings. White iron castings. High strength iron castings.	05	10	2,3,4,5	CO4	2,4			
7	Heat treatment of non-ferrous alloys: Heat treatment of copper, brass, wrought aluminum alloys, aluminum alloy castings, magnesium alloys, titanium alloys, nickel base alloys.	06	12	1,2,4,5,6	CO4	3,4			
8	Choice of heat treatment equipment: Heat treatment plant for bulk steel production. Heat transmission in reheating and heat treatment furnaces. Design of heat treatment furnaces for specific applications.	06	12	2,3,4,5,6	CO5	5,6			

	TOTAL	50 Hours	100%						
Reference Books									
1	Heat treatment –Principles and Techniques, T. V. Rajan and Sharma, Prince Hall.								
2	Metals Handbook-Vol.-II, ASM Metal Park, Ohio.								
3	Heat treatment of Metals – Dovey Gadd and Mitchell Oven.								
4	Industrial Furnaces – Trinks.								
5	Tool Steels-G. A. Roberts, J. C. Hamnker, & A. R. Johnson.								
6	Heat treatment of Metals-Special Report 95, Iron & Steel Institute.								

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering				Academic Year		2020-21		
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme										
Year	I	Core / Elective / Foundation Code: MME2212L Subject:Heat Treatment Practices Laboratory				Credits / Hours per week		03 (Practical)		
Semester	II	Year of Introduction: Year of Syllabus Revision:				Maximum Marks / Grade		50 (TW/VIVA)		
Mode of Transaction		Laboratory Experiments, discussion and viva								
No.	Experiment					Contact Hr	Weightage (%)	BT Level	CO	PSO
1	Exp:1					2	15	1,2,3	CO1	1,2,3
2	Exp:2					2	15	2,3	CO2	2,3
3	Exp:3					2	15	3,4	CO3	3,4,5
4	Exp:4					2	15	4,5	CO4	3,4
5	Exp:5					2	10	5,6	CO5	3,4,5
6	Exp:6					2	10	4,5	CO6	3,4,5,
7	Tutorial :1					2	10	5,6	CO2	5
8	Tutorial : 2					2	10	4,5,6	CO3	5

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme

Programme Specific Outcome (PSO)

Students will be able to

- PSO 1 Develop ability to understand and analyze industrial metallurgy engineering data and provide the appropriate solutions to engineering problems.
- PSO 2 Impart theoretical & practical skills in various metallurgical processes, failure analysis, testing etc. to optimize the industrial procedures to develop the quality & cost effective products.
- PSO 3 Expertise to find out the root cause of real world failures in metallurgical industry and to determine the remaining life of system.
- PSO 4 Emphasis cost effectiveness and environmental safety of the industrial metallurgy field through various dissertation projects.
- PSO 5 Endowed technical competency, ethics, interdisciplinary working skill and contribute society philanthropically.

Syllabus of Courses

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engg				Academic Year			2020-21		
ME (Metallurgical & Materials) (Industrial Metallurgy) Regular Programme											
Year	I	Core / Elective / Foundation Code: MME2213 Subject: Metal Forming				Credits / Hours per week			04 Hrs/ week		
Semester	II	Year of Introduction: Year of Syllabus Revision:				Maximum Marks / Grade			100 Marks		
Mode of Transaction		Lectures									
Course Outcome (CO) CO1 Understanding the basic concept of theory of plasticity CO2 Learn about the basic concept of failure criteria CO3 Learn the effect of friction and lubrication in metal forming process CO4 Understand the basic principle of various forming machines CO5 Study the use of various software techniques for evaluation of different parameters CO6 Understand different metal forming methods											
Unit No.	Topic/Unit			Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and

							(Ent)/ Skill Development (SD)	developmental needs	Professional Ethics (PE)
1	Metal forming processes in manufacturing. Variables. Classification and brief description of metal forming processes.	8	16	1,2	CO1	1,2,3	EMP, ENT, SD	G	ES, PE
2	Plastic Deformation: Strain and strain rate. Simple state of stress. Flow stress of metals. Representation of flow stress data. Tresca and Von mises yield criteria. Power and energy of deformation. Effective strain and effective strain rate.	6	12	1,2	CO2	2,3,4			
3	Friction and temperature in metal forming. Characteristics of lubricants used in metal forming. Lubricity and frictional shear stress. Ring compression test. Heat generation and heat transfer in metal forming processes. Temperature in quasi-continuous forming and those used for forming discrete parts.	6	12	1,2,3,4	CO3	2,3			
4	Principles of forming machines: Interaction between process requirements and machines. Classification of metal forming machines. Time dependent characteristic data. Presses and hammers for cold and hot forming of discrete parts. Different types of hydraulic presses, mechanical and screw presses.	8	16	1,2,3	CO4	1,3			
5	Approximate methods of analysis and application to simple forming operations, open and close die forging with examples.	6	12	1,2,3,4,5	CO5	4,5			
6	Computer aided design and manufacturing and application to impression die forging. Hot extrusion of rods, tubes and shapes. CAD/CAM applications in hot and cold extrusion	6	12	1,2,3	CO6	5			
7	Rolling of strips, plate, sheets and shapes. Drawing of rods, wires, shapes and tubes. Energy and stresses in these processes.	4	8	1,2,3	CO6	2,5			
8	Die materials and die manufacture. Recent developments in metal forming technology and application of FEM to simulation of metal forming.	6	12	1,2,3	CO6	4,5			
	TOTAL	50 Hours	100%						

Reference Books	
1	Mechanical Metallurgy – G. E. Dieter, Mc. Graw Hill.
2	Metal forming – Fundamentals and Applications, ASM.
3	Handbook of Metal Forming by ASM volume 14A and 14B.

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: ME (Metallurgical & Materials)(Industrial Metallurgy) Regular Programme

Programme Specific Outcome (PSO)

Students will be able to

- PSO 1 Develop ability to understand and analyze industrial metallurgy engineering data and provide the appropriate solutions to engineering problems.
- PSO 2 Impart theoretical & practical skills in various metallurgical processes, failure analysis, testing etc. to optimize the industrial procedures to develop the quality & cost effective products.
- PSO 3 Expertise to find out the root cause of real world failures in metallurgical industry and to determine the remaining life of system.
- PSO 4 Emphasis cost effectiveness and environmental safety of the industrial metallurgy field through various dissertation projects.
- PSO 5 Endowed technical competency, ethics, interdisciplinary working skill and contribute society philanthropically.

Syllabus of Courses

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering		Academic Year				2020-21			
ME (Metallurgical & Materials)(Industrial Metallurgy) Regular Programme											
Year	I	Core / Elective / Foundation Code: MME2214 Subject: Powder Metallurgy			Credits / Hours per week				04 (Theory)		
Semester	II	Year of Introduction: Year of Syllabus Revision:			Maximum Marks / Grade				100 (Theory)		
Mode of Transaction		Lectures and Laboratory									
Course Outcome (CO) CO-1: Studying history, scope and limitation of powder metallurgy CO-2: Understanding and learning advanced powder manufacturing processes CO-3: Studying of powder characterization CO-4: Learning special consolidation processes for powders CO-5: Knowledge of powder sintering processes CO-6: Understanding of sintering mechanisms CO-7: Knowledge of various industrial application of Powder Metallurgical Products CO-8: Study of advance topics in Powder Metallurgy											
Unit	Topic/Unit			Contact	Weightage	BT	CO	PSO	Elements of	Relevance to Local	Relation to Gender (G),

No.		Hours	(%)	Level			Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	(L)/ National (N)/ Regional(R)/Global (G) developmental needs	Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Brief review and history of developments in powder metallurgical science and technology. Scope and limitation of powder metallurgy.	06	12	1/2	CO1	1,2	Emp, Ent, SD	G	ES
2	Advanced powder and particulate production techniques-such as subsonic and ultrasonic atomization, rapid solidification process (RSP) by splat quenching, spray-coprecipitation technique, freeze-drying process, sol-gel method, spray-drying method, mechanical alloying etc.	08	16	1/2/3	CO2	2,3,4			
3	Poder characterization: Morphological characterization, crystallographic characterization and chemical characterization- a general review of fundamentals.	04	8	1/2/3/ 4	CO3	2,5			
4	Special consolidation processes such as injection moulding, isostatic pressing, hot pressing, hot isostatic pressing, forging and rolling of powder metallurgical billets, powder extrusion, spray and plasma coating of powders, dynamic compaction processes.	10	20	1/2/3	CO4	5			
5	Sintering of metal and alloy powders: Sintering practice, sintering atmosphere, sintering furnaces, and atmosphere generators. Concept of solid-state sintering, liquid phase sintering, infiltration process.	06	12	1/2/3	CO5	4.5			
6	Sintering mechanisms: Driving forces in sintering reaction and different activated sintering processes.	06	12	1/2	CO6	3,5			
7	Application of Powder Metallurgy in cutting tools, friction and antifricion components, porous materials, dispersion strengthened alloy systems, electrical and magnetic materials, and automobile applications of Powder Metallurgy parts.	06	12	1/2/3	CO7	2,3			
8	Advance topics in Powder Metallurgy	04	8	1/2	CO8	1-5			
	TOTAL	50	100%						

		Hours						
Reference Books								
1	B. K. Datta, "Powder Metallurgy: An Advanced Technique of Processing Engineering Materials", PHI Learning Pvt. Ltd. (2014)							
2	Traian Florin Marinca, Bogdan Viorel Neamtu, Florin Popa, "Powder Metallurgy and Advanced Materials", Materials Research Forum LLC (2018)							
3	A.K. Sinha, "Powder Metallurgy", Dhanpat Rai Publications							
4	Randall German, "A - Z of Powder Metallurgy", Elsevier Science (2005)							

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Metallurgical & Materials Engineering				Academic Year		2020-21		
ME (Metallurgical & Materials/Industrial Metallurgy) Regular Programme										
Year		I	Core / Elective / Foundation Code: MME2214L Subject: Powder Metallurgy Laboratory				Credits / Hours per week		02 (Practical)	
Semester		II	Year of Introduction: Year of Syllabus Revision:				Maximum Marks / Grade		50 (TW/Viva)	
Mode of Transaction			Experiments and tutorials							
No.	Experiment					Course Code	BT Level	CO		PSO
1	Powder metallurgical parts						1,2	CO2		4,5
2	Powder characterization: Sieve Analysis						2,4,5	CO1		2,3,4
3	Powder characterization: Microscopic observation to determine size of powder						2,4,5	CO1		5
4	Apparent density, Tap density, flow rate determination						2,4,5	CO1		4.5
5	Powder compaction						1,2,3	CO3,CO4		1,2
6	Electric conductivity measurement						1,2,6	CO4,CO6		5
7	Powder production by electrolysis process						1,2,3	CO1, CO3, CO6		3,5